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### Journal Item

#### How to cite:

Ison, Ray (2018). Governing the human-environment relationship: systemic practice. *Current Opinion in Environmental Sustainability*, 33 pp. 114–123.

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Version: Accepted Manuscript

Link(s) to article on publisher's website:

<http://dx.doi.org/doi:10.1016/j.cosust.2018.05.009>

<https://authors.elsevier.com/a/1X7yn6gsyPU5-s>

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## ***Current Opinion in Environmental Sustainability***

### ***Issue title: Global Environmental Change***

#### ***Title.***

## Governing the human-environment relationship: systemic practice

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#### ***Abstract***

In attending to contemporary breakdown in human-environment relations rarely is a co-evolutionary- dynamics framing employed. Framings in terms of (i) praxis, or theory informed practical action, and (ii) systems and cybernetic intellectual traditions that evoke relational thinking and practice are also rare. This review addresses these deficiencies and highlights innovations warranted by current circumstances based on (i) understanding dualities; (ii) purposeful action in relation to practice; (iii) choosing to be reflexive, (iv) engaging in purposeful systemic praxis for governing and (iv) appreciating the interplay between systemic sensibility, systems literacy and systems thinking in practice capability. Two promising systems praxis trajectories for improving human-environment relations are explored. The case for systems thinking in practice capacity and capability development concludes the review.

#### ***Highlights***

- The case for a critically reflexive, systemic, praxis that does not adopt a business as usual approach is made as a means to rebuilt foundations of thought and action for governing human-environment relations in the Anthropocene
- Praxis innovation requires understanding distinctions between purposeful and purposive behaviour and the implication of thinking in terms of dualisms and/or dualities; these concepts are explained
- Systemic practice incorporates systematic practice and grows from cultivating systemic sensibility and investing in systems thinking in practice (STiP) literacy, competency and capability
- Two praxis lineages that show promise for improving human-environment relations and acts of governing these relations are reviewed: (i) transition and transformation studies and (ii) practice labs, including watershed systems science
- Development of our capabilities to think and act systemically within conducive institutional ecologies (rather than systematically in reductionist, mechanistic, linear cause and effect ways), is an opportunity we have and thus an urgent priority

## Governing the human-environment relationship: systemic practice

### 1. Introduction: trajectories in the human-environment relationship

Contemporary lived experience is of a deteriorating human-environment relationship even for those living in urban cocoons insulated from the vagaries of the biophysical world. Expression of this fractured relationship comes under many rubrics including: sustainable development [1]; sustainability science [2]; earth systems science [3]; planetary boundaries [4]; resilience design [5]; post-normal science [6]; sustainability transitions [7] and transdisciplinary and/or transformation research [8, 9]. The situation of concern in these different discourses is framed at the level of the whole earth [10], or at sub-system levels, such as cities [11] or watersheds [12] but only rarely is the human-environment relationship framed in terms of co-evolutionary dynamics [12, 13, 14]. Which of the many framings is adequate to our circumstances and to acts of governing is an open question that demands critical scrutiny. Expressions of human-environment relational breakdown are not new within the Western intellectual tradition. As Wulf [15] outlines in her ‘intellectual biography’ of Alexander von Humbolt, he was aware from at least 1799 of the ‘destruction of forests and of humankind’s long term changes to the environment’ including ‘ruthless irrigation and the “great mass of steam and gases” produced in industrial centres’ (p.213). Despite 200+ years of awareness the quality of the human-environment relationship continues to deteriorate, described by some as the crisis of the Anthropocene [16, 17].

Often missing from intellectual framings of human-environment relations are: (i) concerns with practice, particularly praxis, or theory informed practical action, and (ii) understandings built on scholarly awareness of systems and cybernetic intellectual traditions that evoke relational thinking and practice, concerns with feedback dynamics and how these effect the praxis of governing [18, 19]. This review sets out to address these deficiencies and highlights some areas of innovation warranted by current circumstances, including our 200+ year history of failure to transform our manners of living so as to effect more viable trajectories in human-environment relations.

To write about ‘trajectories in the human-environment relationship’ first requires explanations of how and why I conceptualise each term in this phrase in the way that I do. Scholarly writing demands an appreciation that human communication is a dance of responsibility between (in this case) a writer and a reader. All terms come with a history and experience suggests that recognising words on a page is not the same as appreciating the underlying conceptualisation being used. For example, taking a systems view of the ‘environment’ is consistent with its etymological origins from the old French word ‘environer’, a verb meaning to envelop, surround, enclose, wrap, conceal or encircle. As a noun, environment thus means the state of being environed or the action of being environed. I want to emphasize that, following the logic of a duality (and not a dualism – see Box 1), it is not really appropriate to speak of THE environment as something external to, and independent from, us. When treated as a dualism the concepts human (or social system) and environment (or biophysical system) lose the sense of a related but dynamic unity. Instead, the sense I seek is of an environment not different from ourselves, but more a reflection of ourselves [20].

#### Box 1: Duality and dualism

Light can be treated as both a wave and a particle depending on the experiment we, as observers (or experimenters), have decided to use to observe its behaviour. This apparent paradox, i.e. wave-like behaviour and particle-like behaviour, was described for many years as the ‘wave–particle dualism’ which implied they were separate or opposite phenomena. The term used to describe antagonistic or negating opposites is a dualism, e.g. mind/matter,

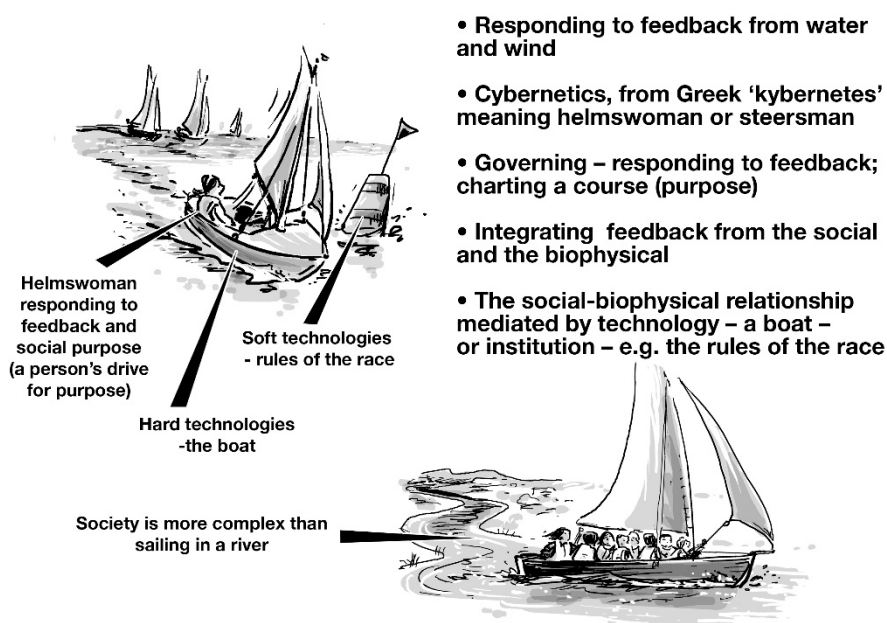
objective/subjective. Two concepts form a dualism when they belong to the same logical level and are viewed as opposites. The logic behind this dialectic is negation. Dualistic thinking is a product of the prevailing objectivist Cartesian world view with its orthodox logic under which we are still brought up. Dualisms are responsible for ephemeral and endless debates, e.g. centralization versus decentralization. Dualistic or either/or thinking can often represent a trap [21, 22].

Recognizing that phenomena we observe in 'nature' are not independent of our observing resolved the paradox by appreciating that wave-like and particle-like behaviour are complementary and constitute a duality. Taken as a whole they do not negate each other but constitute a unity or whole: another common example taken from ecology is the predator–prey relationship. Two concepts form a duality when they belong to two different logical levels and one emerges from the other. The logic behind this dialectic is self-reference. Reframing conceptual pairs as dualities rather than dualisms is an opportunity to move towards more relational thinking and practice (praxis). Following this logic the following pairs **would not be** understood as self-negating items but expressions of a key relationship that gives rise to a dynamic in which the whole is different to the parts: environment–system; control– autonomy; constraint–freedom; 'what'–'how'; social world – biophysical world. When recognized as pairs participating in a relational dynamic, the potential for more rewarding innovation is created [21, 23].

As exemplified through the actions of doing sailing (Box 2) governing can also be understood in relational terms that comprises interacting elements, including a sailor, or sailors responding to feedback dynamics in actions that maintain the act of sailing as viable, or effective, or not. This metaphor for governing can also be understood as a metaphor for co-evolutionary dynamics that maintain, or not, human-environment relations of particular qualities [26]. It is only by seeking and gaining clarity of what is regarded as 'the whole system' that the question of what needs to be governed, and how, makes sense (Box 2).

**Box 2. A cybersystemic metaphor for governing based on the etymology of the act of governing**  
(Source: Adapted from [26]).

### A metaphor for the praxis of governing



This review first considers the question of purposeful action in relation to practice. Choosing to be reflexive, or to engage in systemic praxis are forms of purposeful action as is governing. The case for reflexivity as central to systems practice is made. Progression from systemic sensibility through systems literacy to systems thinking in practice capability is explored. Two promising systems praxis trajectories for improving human-environment relations are introduced. In the final section the case for STiP (systems thinking in practice) capacity and capability development is summarised.

## 2 Taking purposeful action

### 2.1 Purposefulness

More often than not, we do what we do and then, on reflection (if challenged, asked to explain or justify), attribute purpose to what we have done i.e., attributing purpose is often *ex post facto* rather than *ex ante facto*. Within systems scholarship Ackoff and Emery [27] are seen to have written the classic text on purposefulness. A key distinction for them was between purposive and purposeful behaviour. Purposive action denotes action by another (including non-human others), to which purpose is attributed. By contrast, purposeful action is that which is willed by the actor. These distinctions operate in daily life when we attribute purpose to someone or to a group without involving them in the attribution of purpose i.e., purposive behaviour is open to misinterpretation as to its purpose. On the other hand, engaging in reflections and/or conversations about purpose are critical to 'identifying ways to realize more flexible, decentralized, and networked approaches to engage our big collective problems' which 'is the intellectual challenge of the decade [2010-2020]' [28]. For public organizations of the future, Khademian [28] argues that 'the clear[er] we are about the organizing purpose, the more decentralized and immediate the accountability processes can be'; this shift is urgently needed for effective governing in the Anthropocene [26, 29, 30].

A capacity to make novel choices in novel contexts is necessary for purposefulness to be enacted. An entity (person, group, machine or policy) that can be seen to behave in different ways in any one of a set of different environments, but nonetheless produce only one outcome, is goal-seeking, not purposeful. This is why goal-seeking understandings and behaviours limit practice and thus innovative possibilities [31, 32]. By contrast with thermostats, people are obviously able to be purposeful, and so are certain types of social groups. They can purposefully engage in single, double or triple-loop learning [33, 34] or different levels of learning [35] in order to achieve their purpose. Thus servo-mechanisms (i.e., mechanistic control systems including targets, objectives and key performance indicators) are goal-seeking not purposeful [18]. Organizations can also aspire to be purposeful and to build their practices on articulations and re-articulations of purpose [27, 28, 31, 36].

Exploring, articulating and agreeing purpose is itself a purposeful activity. It is an activity common to many, if not all, practices associated with enacting systems methods and methodologies [31, 37, 38]. Within soft systems methodology [SSM; 31, 38] simple but powerful distinctions made between Why, What and How enable purpose to be explored in relation to a created system of interest. Participants using this approach come to realise that there are many possible Hows (sub-systems) for any given What (system) and Why (supra-system) combination and that functionally different outcomes in the same situation arise with changed Whats in pursuit of a given, or changed, Why (i.e. purpose) [31]. Bunch [39] provides evidence of the efficacy of using SSM, and other systems approaches, in effecting improvements in human-environment relations in a diversity of contexts.

### 2.2 Purposefulness and practice

All practice is situated and embodied [24, 18] but all too often an attitude of 'it goes without saying' is adopted; this includes science and research practice. For this reason a central theme of this paper

is that researcher/practitioner reflexivity is a necessary pre-condition for any attempt to effect change for the better in the human-environment relationship. Why? Because we humans need to act into the future knowing what it is that we do when we do what we do [40, 41, 18]. Just as a title frames a paper, so do the understandings and implicit or explicit framings of each participant in any collaborative endeavour [42, 43, 44]. Engaging with complexity and uncertainty, key framings for any situated attempt to change human-environment relationship trajectories, requires personal attributes centred on reflexivity – or the capacity to do reflection on reflection. Doing this is a second-order process involving recursion – performing an operation on itself. Central to reflexivity is being aware that: (i) all practice is situated; (ii) all observations require an observer; (iii) everything said is said by someone; (iv) all knowing is doing, and (v) all observers, practitioners, actors have a history, a tradition of understanding out of which they think and act [18, 40, 41, 45].

### 2.3 Being reflexive, being systemic

The distinctions between purposeful and purposive, both adjectives, when used in relation to the concept of ‘behaviour’ or ‘system’ are relevant [31]. To speak of a purposeful system admits one’s own agency, or that of a group, who take responsibility for the formulation of a *system of interest* as an epistemological device, a way of knowing about, or acting to change a situation of concern. To speak of purposive systems involves an interpretative leap which at worst exhibits ontological naivety – the belief that *a priori* systems exists to which purpose can be attributed (i.e. purposive behaviour).

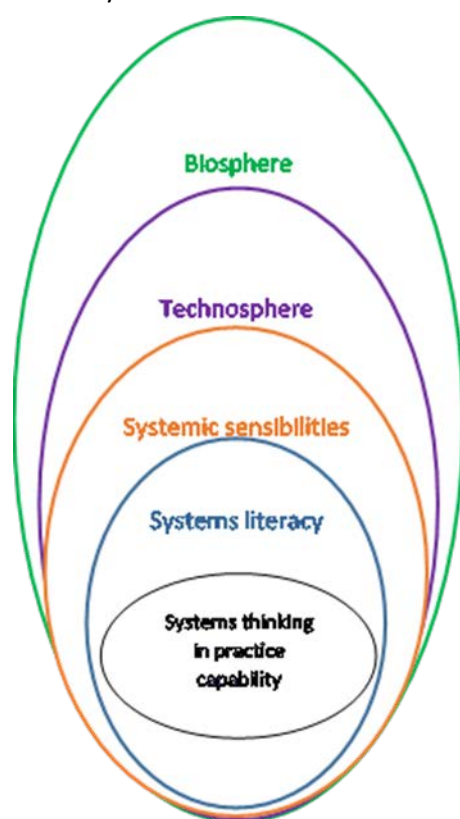
To be systemic is also to be reflexive; all practice is situated, we are each the product of an evolutionary, biological, cultural, family and intellectual/social history and we live in language (a situation where language uses us as much as we use language) [45, 41, 18]. It follows that all systems are formulated by someone and to formulate a *system of interest* requires relational, dynamic thinking. Being systemic also means being open to the circumstances in any given situation and being capable of moving up and down levels of abstraction (as captured in the terms meta-system, system, sub-system and so on) [27, 31, 38]. Being systemic is not the same as being systematic; the latter involves acting in a step-by-step, generally linear, manner. Systems practice comprises systemic and systematic practice understood as a duality [18].

Popa et al [46] claim that ‘the importance of a reflexive questioning of values, background assumptions and normative orientations of various approaches to sustainability in transdisciplinary research is not sufficiently acknowledged.’ Boström et al [47] argue that reflexivity is ‘connected to topics such as modernity, governance, expertise, and consumption’ and is ‘presented as a means for taking constructive steps towards sustainability as it recognizes complexity, uncertainty, dilemmas, and ambivalence.’ [p. 6]. In this critical review of reflexivity in environmental sociology they identify the main origins of the concept in the work of Giddens [48] and Beck [49, 50] on reflexive modernization including Beck’s ‘risk society’ (Box 3). Their concerns involve the relations between technology, science, politics, the state and the economy in ‘simple modernity’ [47]. Reflexive modernization critiques ‘a cognitive and instrumental approach in which uncertainty, complexity, and ambivalence are handled through the use of rationality and technology’ and ‘holds that this approach to problem-solving inevitably leads to unintended and negative consequences.’ It is argued that as the side effects of the reliance on rationality and technology multiply, realisation dawns, because complex issues remain unresolved by traditional instrumental approaches, and ‘a reflexive turn emerges – in Beck’s terminology, ‘reflexive modernization’ or the ‘world risk society’ [47; p. 6-7].

The elements of ‘simple modernity’ remain ascendant; Popa et al [46] observe that ‘despite having challenged the influential conception of science as a value neutral inquiry in the exclusive responsibility of highly trained and specialized experts, the prevalent sustainability discourse continues to construe scientific reliability and social legitimacy as distinct requirements that have to be pursued in parallel and traded off against each other.’ In this field there is little focus on reflexivity as praxis, particularly a systemic praxis; rarely is the full gamut of systems scholarship drawn upon [51, 52, 18]. Addressing these deficiencies requires clarity about the constitution of praxis.

#### 2.4 Engaging in praxis

The meaning I attribute to praxis is based on an understanding that we never see or act ‘theory free’. Why? Because we live a life of accepting and rejecting explanations that have theoretical



entailments. This said, we can try to be open to our circumstances and through reflection in and on action [53, 54] attempt to become aware of the theoretical assumptions which shape our experienced world. As embodied traditions of understanding are never fully escapable, then it makes sense, particularly in situations of complexity and uncertainty, to admit others into the conversation, or deliberation, because we each bring multiple partial perspectives to bare on a situation of concern (this is the basis of arguments for moving beyond consultation to participation, deliberation and into co-design or co-inquiry) [55, 56, 57, 58]. As long as one is not committed to determinism, praxis can be designed i.e., the circumstances for emergence of a ‘good performance’ can be created just as can be done with good choreography or dramaturgy [59, 60]. When one draws upon, releases or fosters a systemic sensibility and begins to critically engage with the pantheon of systems scholarship (including historical process thinking and philosophy) and begins to embody these understandings in our doings, then systems practice can be said to arise (Figure 1).

*Figure 1. The nested (systemic) relationship between systemic sensibility, systems literacy, systems thinking in practice (STiP) capability within the technosphere and biosphere. The figure is read as systems thinking in practice capability is a sub-system of systems literacy which in turn is a sub-system of a more generalized systemic sensibility and so on (Source: adapted from 17)*

The account of praxis just given is not the same as practice studies or research which seeks to examine how others practice, though there are some overlaps [61]. According to Boström et al [47] ‘Beck [50, 119ff] summarizes the differences between reflection and reflexivity by stating that whereas reflection concerns knowing and knowledge and the belief that more knowledge will increase the problem-solving capacity of institutions and society, reflexivity/self-confrontation concerns unknowing (i.e. unintended and unknown side effects).’ Unknowing may or may not happen as part of a longer term social process (as say with ‘big tobacco’ or perhaps what is now unfolding around divestment from ‘big coal’) or it can be built into one’s own doings, and institutional designs (the human rules of the game that we invent). Future designs can offer affordances that offer greater reflexivity e.g. being reflexive about the revealing and concealing



features of metaphors that shape public policy and daily practice [62, 63, 64]. Boström et al [47] pose a crucial empirical question for environmental sociology and beyond: ‘whether scientific institutions and scientists are endorsing and practicing the explicit questioning of their own assumptions, opening themselves to external viewpoints?’ In other words how is their praxis developing and what constrains praxis innovation, given that these same authors report studies that illustrate ‘how reflexive elements initially contribute to the inspiration and design of policy or innovation processes, but often vanish during the processes themselves’? This is an example of institutional failure; the challenge is how to foster investment in systems literacy whilst developing enabling institutions for supporting reflexive systems thinking in practice.

The praxis of effecting change through the use of systems thinking in practice (STiP) involves a systemic sensibility, some systems literacy (engagement with the history and concepts of systems scholarship) and the capability to do transformative STiP in situations of concern [Figure 1; 17, 18, 26, 65]. To do STiP requires moving beyond a sensibility that appreciates phenomena in relational ways to being able to act so as to transform relational dynamics for the better in situations of concern. The next section explores some promising praxis trajectories.

### 3. Promising systems praxis trajectories: improving human-environment relations

There are a range of praxis lineages beginning to be conserved that show promise for improving human-environment relations and acts of governing these relations. Some explicitly draw on systems scholarship; some may feel that they do, but do so in a limited or non-reflexive way. Some have an articulated praxis whilst others leave the praxis dimensions opaque, or poorly considered. Only a few can be considered to be innovative in terms of contributing to systemic, co-evolutionary governance. In what follows two praxis lineages are briefly reviewed: (i) transition and transformation studies and (ii) practice labs, including watershed systems science.

#### 3.1 Transitions and transformation studies

The two discreet lineages of ‘transition’ and ‘transformation’ studies, have the potential to be synergistic and more purposefully endowed with STiP praxis [67]. Scholars using transition management have also applied concepts of transformation [68, 69]. Fischer-Kowalski and Rotmans [70] outline different schools of thought, and thus praxis traditions relating to transitions; in both the Viennese and Dutch schools systems-theories are drawn upon. In the former, Luhman’s [71] conception of ‘society’ as the structural coupling of a communication system with biophysical compartments is used with the implication that ‘the sociological theory of society as an operationally closed, autopoietic systems of communication rules out the possibility of conceiving it as a subsystem of an ecosystem’ as has often been the case within resilience discourse [e.g., 72, 13]. In contrast the Dutch tradition draws on the concept of complex adaptive systems (CAS): ‘we use complex systems theory to study the dynamics of societal systems in order to derive a collection of guidelines that can be used to direct societal systems’ [70 p. 7]. However, it is claimed (p. 3) that both approaches see ‘a crucial aspect of multi-level dynamics in the notion of emergence: neither can one state be deliberately transformed into the other nor can the process be fully controlled. One deals with autopoietic processes to which orderly governance or steering cannot be applied’. Governing and managing for emergence is consistent with the framing of governing given in Box 2 through the metaphor of governing as enacting a sailing performance in which many of the relational elements are not controllable.

Fischer-Kowalski and Rotmans, [70] outline the key elements of praxis in the Viennese and Dutch transitions schools. The former ‘seems to be able to outline the problem and also some of the



quantities to deal with. But for translation into policy it offers at best some theoretical guidelines and some targets' (p. 6). The Dutch approach (73, 74, 70 comprises (p. 9): (i) problem structuring and establishment of a transition arena; (ii) development of sustainability visions and pathways and a transition agenda; (iii) initiation and execution of transition experiments and, (iv) monitoring and evaluating the transition process. Importantly a 'transition arena' comprises a 'learning network'. The Dutch approach appears to fall in a second-order modality of praxis as outlined by Ison et al [75] though there are epistemological tensions especially with the more recent systems-theoretical traditions that see systems as epistemological devices [18, 31, 38, 75]. Sterling [76] recognises that transition and transformation do not form a dualism but a duality (Box 1). I agree but would add that it is in the hands of context specific practitioners that a dualism or duality is brought forth. Sterling [76] also cautions not to fall into the belief that the most rapid change can come from top-down structured transitions rather than 'unruly bottom-up transformations ...that typically achieve the most profound, sometimes most rapid progressive social changes' (p. 1).

Both lineages adopt framings that may constrain the emergence of a co-evolutionary governance praxis [13]. In transition studies there is a danger that adoption of CAS is done in a reifying way that slips into granting a CAS ontological status. The same applies to social-ecological systems (SES); for Berkes [77] 'people and environment need to be considered together, as social (human) and ecological (biophysical) subsystems ..linked by mutual feedbacks [that] are interdependent and co-evolutionary'(p.1232). However, in the next sentence he goes on to say: "these integrated systems of humans and environment (SES) provide an appropriate unit of analysis.' In both cases the 'as if' elements of a reflexive, epistemological aware systems praxis are lost as is consideration that comes from a framing choice of two systems (social and biophysical) in a mutually influencing co-evolutionary dynamic over time [26]. Norgaard and Kallis [13] also note this lack of conceptual clarity; for this and other reasons a meta-evaluation of the efficacy of transition/transformation discourses and praxis in maintaining, or initiating, improvements in the governing of human-environment relations is warranted [e.g., 78].

### 3.2 Practice Labs: the example of 'watershed systems science'

'Watershed systems science' is a framing choice advocated by Cheng & Li [79]. They point to the challenges of integrating human factors into the study of watershed hydrology and watershed ecology. These authors frame the most significant challenge in terms of 'unknown unknowns' that arise when natural systems and socioeconomic systems in co-evolution (such as watersheds) experience accelerated human activity that irreversibly affects the Earth system [12]. In making the claim that "watershed science focuses on interactions between human and natural systems", these authors move the focus of concern from a system to the relational dynamics between two systems of interest. They thus set the groundwork for how co-evolutionary processes function. 'A dynamic feedback loop from the natural system to the socioeconomic system and means of 'representation of the coevolution of human-nature systems' are needed according to Cheng & Li [79]. Based on extensive research in the Heihe River basin [79, 80] which has contributed to improved governance outcomes, they advocate using whole river basins, or watersheds as praxis laboratories: 'methodologically, macro laws and methods of analyzing a watershed as a whole should be developed, and effort should be focused on achieving these goals by developing operational research methods that combine holism and reductionism.' (p. 1166). To realise this ambition it will be necessary to appreciate that the operation of dynamic feedback loops between the social and biophysical be understood and used purposefully, or nudged by humans, in acts of governing in the cybernetic sense [Box 2; 29, 18]. It will also be necessary to appreciate that the feedback and feed-forward dynamics between a social and biophysical system are mediated by human invented technologies, including institutions (Fig. 1).

Improving the praxis of watershed systems science is a topic for more research and development; potential exists for collaboration with public policy scholars [81, 82] who argue for increased deliberative decision making: ‘taking place outside formal political institutions, unstructured public deliberation can exert influences on policy or decision-making inside government organizations through well-coordinated transmission mechanisms between the public and the local government. During this process, well-resourced community organizations and actors play a vital role through their bridging functions to produce dynamic relations of deliberative governance’ [81].

With investment in capability, deliberation too can become a form of systems praxis that can be incubated or cultivated in a lab, such as a watershed or other lab forms. The explosion of social change, whole system change and innovation labs also warrants attention to cross-fertilize experiences, especially in terms of effecting systemic transformations of human-environment relations. It is necessary to know, for example, whether framing watersheds as labs has more to offer in terms of effective governing than past framings such as ICM (integrated catchment management). A recent report [83] poses, and partially addresses the challenge arising from an explosion in social innovation labs that ‘have emerged around the world with the premise to provide alternative and effective approaches for tackling systemic problems and bringing about positive social transformation. These labs have rapidly grown in number and popularity alongside the social innovation movement, and have gained the attention of practitioners, researchers, and policy makers.’ This report asks: ‘What exactly are they and how do they function? What are the most effective methods they use? What are the challenges they face? Have they delivered the promise on which they were built?’ These are all questions worthy of ongoing attention especially in the context of effectively enacting the UN sustainable development goals [84].

#### 4. Final reflections: STiP capacity and capability development

An opportunity exists for more investment in STiP capability – acting purposefully and with reflexive intent to choreograph one’s situated and embodied systemic praxis [17, 85]. Praxis development, depends on building systems thinking in practice (STiP) literacy, competency and capability [66, 29]. Aragón and Macedo [86] argue for capacity development to be understood as systemic learning, claiming this ‘makes it possible to build improved strategic and methodological clarity .... capacities to contribute more effectively to emergent, social change in highly complex environments.’ The rationale for investment in STiP capability can be appreciated from documented case studies in the OECD report “Systems Approaches to Public Sector Challenges. Working with Change” (see Box 3).

##### Box 3. Employing systems approaches in public sector innovation and change: findings from case studies [87].

Four systemic change case studies from diverging contexts were studied and reported in 2017 by the OECD. They analysed “how systems approaches have been applied in practice to: prevent domestic violence (Iceland), protect children (the Netherlands), regulate the sharing economy (Canada) and design a policy framework for conducting experiments in government (Finland). The case studies provide an overview of the context of the change process, steps to initiate and carry out systems change, and its impacts.” The findings highlight “the complexity in terms of problems examined and government levels involved, and the difficulties of working across silos. The cases show that systems approaches can be very beneficial in redefining government outcomes and structuring change, but that transformation also requires various resources, such as flexible finances, time, political coverage, systems thinking capabilities, and independent brokers. The empirical examination also reveals the ongoing need of systems thinking [an investment in capacity and capability issue] and

iterative processes as implementing systems change invariably unearths unforeseen effects..” (p. 69).

The Finnish case study reports on the production of a ‘licence to experiment’ within government that was informed by systems thinking in practice. A focus was on generating feedback processes (a key systems concept) that operate between policy implementation and new policy design, processes that were not functional at the time. A multi-method approach with the aim of making ‘steering mechanisms’ for governing more effective was adopted.

Development of our capabilities to think and act systemically within conducive institutional ecologies (rather than systematically in reductionist, mechanistic, linear cause and effect ways), is an opportunity we have and thus an urgent priority. No governance system is immutable; all can be reinvented. Reinvention is a practice that brings into question how practice (what we do when we do what we do) is understood, enacted and mediated by institutions, technologies and structures i.e., situated in the technosphere and biosphere (Fig. 1). As Norgaard and Kallis [13, 88, 89] acknowledge, there are epistemological tensions in conducting co-evolutionary research; the future agenda is far from clear. However, the systemic and the systematic are not an either/or choice, a dualism (Box 1) but together comprise a holistic praxis response that opens up more ethically defensible possibilities for action.

Most contemporary societies have over invested in the systematic at the expense of the systemic, and the balance in terms of understanding and investment needs to be changed in favour of the systemic. Scranton [90; p. 27] points to a clear choice:

‘We can continue acting as if tomorrow will be just like yesterday, growing less and less prepared for each new disaster as it comes, and more and more desperately invested in a life we can't sustain. Or we can learn to see each day as the death of what came before, freeing ourselves to deal with whatever problems the present offers without attachment or fear’.

He is in effect advocating a critically reflexive, systemic, praxis that does not adopt a business as usual approach but actively seeks ways to rebuilt ‘foundations of thought and action’ [90] as a manner of living and governing in the Anthropocene.

## 5. Acknowledgements

This paper was written with support from the “Integrated modeling and prediction of the water-ecosystem-economy in the Heihe River Basin (No. [91425303](#))” project led by Prof. Xin Li (CAS); the author thanks Prof. Xin Li for support and Professors Boje Fu and Yongping Wei for the invitation to contribute a paper to this volume. I thank the referees and Dr Michael Santhanam-Martin for their helpful comments.

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To transform further towards a mature watershed systems science the authors urge the systemic use of the concept 'system' and bringing in new social-oriented sub-disciplines of hydrology. It is proposed that watersheds such as the Heihe River Basin could be further developed as an iconic watershed for watershed systems science—a new paradigm to understand and govern the impact of human activities on the earth's surface in the Anthropocene.

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This book shows how to do systems thinking and translate that thinking into praxis (theory informed practical action). It exemplifies managing or governing in situations of complexity and uncertainty across all domains of professional and personal life. It is argued that the development of capabilities to think and act systemically is an urgent priority because humans are now a force of nature, affecting whole-earth dynamics including the earth's climate creating an Anthropocene or Capitalocene.

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The case for watershed science, to understand and predict the behavior of complex watershed systems and support the sustainable development of watersheds is made. Challenges include difficulties of understanding complex systems, achieving scale transformation, and simulating the co-evolution of the human-nature system. These difficulties are fundamentally methodological challenges.

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This paper focuses on SDG 17—the means of implementation—and the role of systems thinking in practice for supporting both competence and SDG implementation capability. An action research inquiry exploring the praxis (theory-informed-action) challenges of applying systems thinking in practice in contemporary workplaces ranging from in-field development projects to government administrations and business ventures is reported. Findings from this inquiry are used for developing an action-learning platform for SDG implementation.

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